ON THE IMPORTANCE OF THE CORPUS STRIATUM AND THE BASAL FORE-BRAIN BUNDLE, AND ON A BASAL OPTIC-NERVE ROOT.[1]

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MEYNERT was the first to apply the comparative-anatomical method to the study of the course of nerve tracts in the brain. From the very start, this method brought to light many interesting facts of fundamental importance; and yet, strange to say, very few investigators have employed this method. At the present time, we may claim that the work done during the last decades has advanced our knowledge of the gross anatomy of the brain to such a point as to enable us to determine the homologous parts of the cerebral organism throughout the entire animal series. There can be no doubt now which parts of the brain represent the mid-brain, which the inter-brain, and such difficulties as remained have been finally removed by the clever researches of Rabl-Rückhardt. These difficulties were greatest concerning the interpretation to be given to the various portions of the brain of osseous fishes; but even here we can now see clearly. In a former publication[2] I have shown why it is that in spite of a considerable number of investigations our knowledge of the course of nerve tracts in the animal brain is so much more limited than that of the external configuration of the brain. It was shown that even in the lower animals, the Selachians for

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[1] This paper was read by the author at the twelfth annual meeting of the S W. German Neurologists, etc., at Strassburg. Translated by the Editor.

[2] Anat. Anzeiger, 1887.

instance, the structures lying caudad of the fore-brain were so complicated that their relations were scarcely simpler than those of analogous portions of the brain in man and mammals. My own researches, with Weigert's staining methods, upon the lower animals, including a study of frogs, amphibia, and reptiles, have forced me to the conclusion that the structure which subserves the simple so-called lower functions of the nervous system is substantially the same in all animals. Little headway can be made in these studies even with the lower animals if adult individuals are examined, as any one can convince himself who will take the trouble to study the rather complicated section through the mid-brain of Selachians. If one adopts, however, the method of comparative embryology and investigates the development of medullary sheaths in lower animals, the relations of the parts exhibit unusual simplicity and clearness. In this way I have succeeded in unravelling a very considerable portion of the central nerve tracts of the sensory nerves of the brain.

It is my object in the present paper to discuss another question in cerebral anatomy which we can solve more satisfactorily still by the aid of comparative anatomy.

It is well known that there is considerable controversy regarding the fact whether nerve fibres actually emanate from the corpus striatum of the fore-brain, or whether the corpus striatum is merely a way station through which nerve fibres pass. Up to the present time, the solution of this question has been attempted by the examination of the brains of adult or growing mammals. The great difficulty that we have to contend with in such investigations is that we have to take into account the innumerable fibres of the corona radiata, the greater part of which fibres unquestionably merely passes through this ganglion. That this is true of a very large portion of the fibres coming from the cortex I was able to establish by the study of fœtal human brains.[1] In the seventh and eighth months of pregnancy, the cerebral structure is

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[1] Neurol. Centralbl., 1884, No. 15.

still a very simple one; but later on, so many different sets of fibres acquire their medullary sheaths that the successful staining of these brains reveals a complicated network which it is scarcely possible to unravel. In spite of the fact that certain researches, and particularly the embryological relations of the corpus striatum, argue in favor of the view that fibres issue from the putamen and from the caudate nucleus, as they do from the cortex, yet on account of the difficulties above mentioned it was quite impossible to determine with absolute certainty which view was the more correct one.

The cerebral structure is very much simplified among some of the lower vertebrates. Rabl-Rückhardt showed

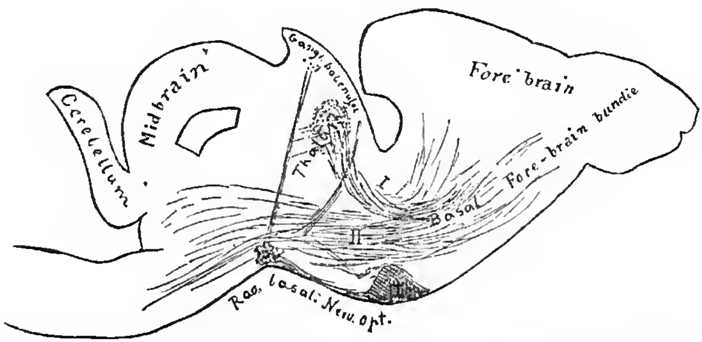

Fig. 1.—Brain of Emys lutaria, sagittal section considerably laterad of the median line.

some years ago that osseous fishes possessed no cerebral mantle with nerve fibres, and my own researches on amphibia and reptiles have taught me that the mantle of these animals contains but very few medullated nerve fibres. In these various animals the main mass of the fore-brain is made up in reality only of the corpus striatum which has a hemispherical nucleus. In reptiles, starting from this nucleus rows of ganglion cells grow into the cerebral mantle. These animals are, therefore, lacking in those very features which complicate the mammalian brain: they are devoid of a corona radiata extending inward from the cerebral mantle.

There is no difficulty in showing in amphibia, reptiles,

and fishes that *a well-marked bundle of fibres does actually issue from the corpus striatum.* The course of this "basal fore-brain bundle" could be traced most easily in reptiles (Lacerta, Anguis, Emys, Tropidonotus). From the prosencephalic ganglion the basal fore-brain bundle passes caudad. In the inter-brain it divides into a coarse-fibred portion (I. in all figures) which ends in the ganglion of the thalamus, thus uniting thalamus and lenticular nucleus, and into a bundle of finer fibres (II. in all figures) which can be traced about as far downward as the oblongata, but in all probability extends even further down.

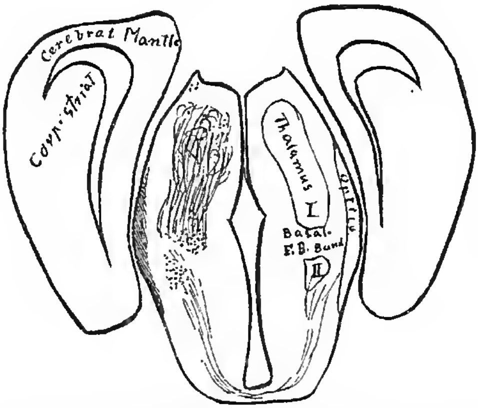

Fig. 2.—Emys lutaria, frontal section through the inter-brain and the posterior portion of the hemispheres.

Immediately before their entrance into the thalamic ganglion a few very fine fibres are found between the right and the left bundle, which fibres present the appearance of a transverse commissure; but I am not convinced that this commissure, which has been seen only by Osborn before me, arises from these bundles. This commissure lies on the floor of the inter-brain, dorsad and frontad of the commissure of Gudden which is immediately adjoining the chiasm. If we designate the commissura gangliorum habenulæ as the dorsal commissure of the thalamus, and call the commissure of Gudden the ventral commissure of the thalamus, then we might give to the commissure described above the name of "median commissure of the thalamus" (commissura thalami medialis). This commissure is not to be confounded with the commissura *mollis* common to reptiles. The commissura thalami medialis I have found in all animals which I have thus far examined (fishes, amphibia, reptiles, and birds). It is particularly well

marked in Selachians ; its homologue in mammals I have not yet made out.

The following conclusions can safely be drawn from these investigations which have been made on simple transparent specimens :

1. Fibres originate in the corpus striatum.

2. The corpus striatum is doubtlessly joined to the thalamus.

3. A bundle of fibres can be traced from the corpus striatum caudad nearly as far as the oblongata.

The conditions above described as occurring in verte-

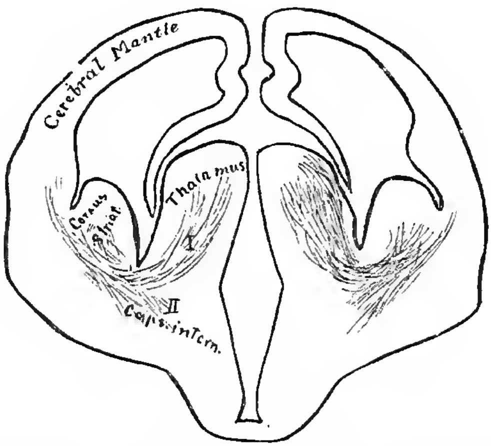

Fig. 3.— Human fœtus of two and a half months. Frontal section through the inter-brain and the hemispheres.

brates are present also in man. Meynert long ago drew this inference, basing it upon specimens of adult brains; but, as was said before, innumerable fibres are there crowded together into a very small space so that nothing can be stated with any degree of certainty. The accompanying frontal section of a human fœtus of two and a half months exhibits very distinctly that of the fibres emanating mainly from the corpus striatum the greater portion passes into the thalamus, whereas the remaining fibres pass lower down through the internal capsule.

It is interesting to observe that not only in man and in

mammals, but also throughout the entire animal series these fibres from the fore-brain ganglion become medullated at a very late period, later than the fibres, for instance, from the inter-brain and mid-brain. Among the amphibia, a very considerable portion of these fibres never becomes medullated (Salamandra, Bufo).

If we are anxious to get at the physiological function of this bundle of fibres, it would seem to be important to examine animals that lead an active independent life during their fœtal period. It is a very surprising fact, therefore, that not a single trace of medullary sheaths can be discovered around the fibres of this basal fore-brain bundle in the larvæ of the frog, salamander, triton, slow-worm (the latter even thirty days after their birth), and ammocœtes; and furthermore that the axolotle exhibits only very few medullated nerve fibres among an enormous number of medullated fibres.[1] All these animals lead an independent existence; they swim, creep, have perceptive and visual powers, take nourishment, escape, flee from the approaching hand; in short, they perform a number of actions in spite of the fact that their fore-brain is joined in very imperfect fashion to the remaining portion of the cerebrum.

The embryological development of the human fore-brain proves that medullary sheaths are developed whenever certain portions of the brain come into active use. If this be correct, the larvæ spoken of above represent highly organized animals that do not make use of their fore-brain.

Of late years, the cerebral physiology of lower vertebrates has aroused considerable interest. It would be desirable if more attention were paid in future, than hitherto, to the inner anatomical structure of the brains here under discussion. In this way only will it be possible to determine the function of this fore-brain bundle

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[1] In the new-born sparrow and in the pigeon that has just emerged from the egg, this bundle is still without medullary sheath. In the amphibia, triton, and bufo, the greater portion of this basal fore-brain bundle remains non-medullated during the entire period of life.

which, since it is present in all animals, must be of fundamental importance.

After reading the above paper and in connection with a communication made by Stilling on the origin of the optic nerve, a report was made on a well-marked optic-nerve root in reptiles ; the same root I have seen in amphibia and fishes. It arises at the base of the brain from a ganglion which must be interpreted to be the corpus mammillare, since it lies between the tuber cinereum and the emerging oculo-motor nerve. This ganglion is connected by a distinct bundle of fibres with the ganglion habenulæ, from which the optic nerve for the parietal eye of reptiles arises. This can be made out in lizards and tortoises. Fig. 1 exhibits this basal optic-nerve root.